RESEARCH ISSUE
SUMMER 2016

WESTERN MICHIGAN UNIVERSITY

W Magazine

Targeting our most precious resource

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Full Frame

Fountain Plaza is one of the most picturesque spots on campus. The splendor of the plaza is especially apparent at nightfall.

Research

Dear Friends,

Beauty is in the eye of the beholder, and the view offered here is spectacular.

This issue of our research magazine reflects the beauty, challenges and obligations that are intertwined with the natural resources of our Michigan inland lakes and Great Lakes. Water is the basis for life and a resource that must be protected. WMU is doing that on a global scale.

We are stewards of these natural, unsalted lakes and coastal regions. But stewardship comes with responsibility. Ours is to maintain the beauty and to understand our natural resources from a scientific, historical, humanistic and artistic point of view.

Inside this issue, read about our freshwater science and sustainability curriculum, which offers Western Michigan University a means to research the lakes while engaging our students in frontline discovery. In this endeavor, we have partnered with Northwestern Michigan College in Traverse City to expose students to an array of experts and educational experiences.

From a historical perspective, the Great Lakes also have been a pathway to move products to all points on the compass. Negotiating with surrounding states and Canada on how best to protect the integrity of the Great Lakes has a long history. In one of our reports, researcher and historian Dr. Daniel Macfarlane highlights water diversions and treaties that span decades.

But our focus is not limited to this region or to the United States. Utilizing data from NASA satellites, Dr. Mohamed Sultan, head of the Earth Sciences Remote Sensing Lab at WMU, monitors the world's greatest aquifers. He is internationally recognized as one of the foremost scientists studying water resources in Africa and the Middle East. Sultan also has advanced the use of satellite technology to study oceans, hydrologic systems and climate change.

Other research ventures showcased in this edition explore advertising and multiracial identity, public health and a developing discipline known as biogeophysics.

Together, all these endeavors underscore WMU's commitment to diversity in discovery and to serving at the local, state, national, and international levels to make a difference in people's lives. We invite you to learn more about the dynamic discovery underway at this globally engaged public research institution.

Best regards,

John M. Dunn, Ed.D.
President

Daniel M. Litynski, Ph.D.
Vice President for Research

University **News**

A 'Purple Heart University'

During a ceremony in April, WMU was recognized as the first Purple Heart University in Michigan.

Scott E. Wilson, commander of Battle Creek's Chapter 110 of the Military Order of the

Purple Heart, joined WMU President John M. Dunn in a ceremony designed to formally confer the Purple Heart title on WMU.

The Purple Heart is awarded to members of the United States armed forces who are wounded in combat. The award dates back to 1792 when President George Washington first launched the award as the Badge of Military Merit.

The nation's Military Order of the Purple Heart, which was chartered by Congress in 1958, awards the Purple Heart University designation to universities for outstanding service to military service members and veterans, and their dependents and survivors.

The resolution honoring WMU lauded the University for its "proud tradition of recognizing all the men and women who have selflessly served their country and the university in the armed forces."

"One of the things I'm most proud of is our focus on empowering those who have served their country well," Dunn said in response to the award. "It's not about the University. It's about people coming together to do the right thing and ensuring our veterans feel honored and valued." ■

State earmarks funding for geological mapping

The Michigan Geological Survey at WMU will be infused with $500,000 in state funding to do statewide geological mapping to assess, protect and carefully develop vital natural resources.

Yellich

The money will be used to immediately prioritize state needs, begin comprehensive assessment and mapping, and develop collaborations with industry to assess subsurface storage capacity and water, aggregate, gas and oil resources. Such assets are critical to helping Michigan rebuild its infrastructure and maintain a healthy environment.

"Our natural resources are all geologically based," notes John Yellich, director of the Michigan Geological Survey, which was formally moved to WMU by legislative action five years ago.

"These resources are so important to us we can't afford not to use science to protect them and make decisions about how they can be developed and used."

University officials had praise for both the original decision to locate the survey at WMU and the new decision to begin the process of funding the survey in a way that allows it to take full advantage of its potential as both an environmental protection and economic development tool. Matching federal funds, for instance, are being left on the table because the survey does not have the ability to apply for them.

With only 10 percent of the state's needed areas mapped to date, Michigan is at an economic disadvantage and has fallen behind neighboring states, Yellich says.

Federal matching funds for mapping have been available for the past 24 years, but Michigan has used that opportunity at a much lower rate than other Midwest states.

"We don't need to map the whole state," Yellich says, "but we need to prioritize areas of importance and make smart decisions about important areas such as water quality and the need to discover aggregate deposits that will help us rebuild infrastructure. ■

Entrepreneur wins annual $10,000 award

The student entrepreneur behind a new software program has won the second Brian Patrick Thomas Entrepreneurial Spirit Award.

Joshua Teo, a mechanical engineering graduate student, received the $10,000 award for his invention Durabilika, interactive cloud-based durability analysis software.

Teo

The award is given annually to a company in Starting Gate, WMU's student business accelerator.

Durabilika helps design engineers at manufacturing companies predict the service life of their products through cloud-based software, FatigueNet. Teo created the software while pursuing his undergraduate degree in mechanical engineering when he realized most products used to serve the same function were either extremely expensive, difficult to learn, or both.

"We are honored to receive this award," Teo says. "With this type of funding, we're able to continue to expand our research on the product, working to make it easier to access and use."

Durabilika was co-founded by Dr. Daniel Kujawski, professor of mechanical and aerospace engineering at WMU.

The award won by the duo was established by Brian Thomas, an alumnus who earned his degree in industrial marketing in 1996. Formerly the chief executive of Otterbox, Thomas is today the CEO of Jemez Technology. ■

WMU will bring noted oceanographer and National Geographic Society Explorer-in-Residence Sylvia Earle to Kalamazoo this fall. Earle's address, "Exploring the Deep Frontier," is set for 7 p.m. Thursday, Oct. 6, at the Chenery Auditorium, 714 S. Westnedge Ave. Her appearance is part of a "Science and the Human Endeavor" speaker series, slated talks jointly sponsored by the Lee Honors College and the University Center for the Humanities.

Famed composer awarded honorary degree

Renowned French composer Michel Legrand, who has written the scores for more than 200 films and television shows, was awarded an honorary WMU degree during a ceremony in May.

Legrand gets hooded as part of his honorary doctorate ceremony.

In Kalamazoo to perform at the Gilmore International Keyboard Festival, composer, conductor and pianist Legrand was the recipient of an honorary Doctor of Humane Letters degree.

The three-time Academy Award and five-time Grammy Award winner was lauded in a brief formal degree ceremony.

WMU President John M. Dunn read the formal degree citation, noting that Legrand's work over the years "bridged the musical styles of European classical, American jazz and popular music."

The citation praised Legrand's artistic and scholarly achievements as significant, calling his body of work "an exceptional model of Western Michigan University ideals and aspirations for students, faculty and alumni."

Legrand told those attending the event that he was honored to be able to accept the award.

"You may call me 'Doctor' from now on," he said. "I'm extremely happy and I will try to go on with my life doing better than I have done so far."

Following the degree presentation, a short video was shown displaying congratulatory messages from such colleagues as Tony Bennett, Jerry Lewis, Barbra Streisand, Quincy Jones, John Williams and others.

Legrand is best known for classic film scores for such motion pictures as "The Thomas Crown Affair," "Summer of '42" and "Umbrellas of Cherbourg." He won the first of his three Academy Awards in 1968, when "The Windmills of Your Mind" from "The Thomas Crown Affair" was lauded as best original song.

For Kalamazoo's famed Gilmore Festival this year, the Michel Legrand Trio performed twice in the festival's jazz club setting, and included two WMU faculty members—Tom Knific on bass and Keith Hall on drums.

The festival finale included the world premiere of the newly commissioned "Concerto for Piano and Orchestra" by Legrand. ■

And the *DownBeat* awards go on

Jazz studies students continue their streak of winning multiple awards in *DownBeat's* annual Student Music Awards, taking five prizes in this year's contest.

The multiple wins put WMU in the company of such esteemed music schools as the University of Miami and the University of North Texas. No other Michigan university received an award. WMU tied for fourth in this year's contest with the University of Northern Colorado and Sacramento State University.

"Though it has become an expectation to hear such news, it never gets old and it certainly does not diminish our understanding of the quality and dedication it takes to sustain such consistency," says Daniel Guyette, dean of the WMU College of Fine Arts.

This year's WMU honorees, the category of their award and their director or professor, are:

- James Richardson, Vocal Jazz Soloist, College Winners, Gregory Jasperse, professor.
- Gold Company, Large Vocal Jazz Ensemble, College Outstanding Performances, Gregory Jasperse, professor.
- Andrew Saliba, Blues/Pop/Rock Soloist, College Outstanding Performances, Tom Knific, professor.
- Sam Alhadid, Blues/Pop/Rock Soloist, College Outstanding Performances, voice, Gregory Jasperse, professor.
- Mas Que Nada, Latin Group, College Winner, Tom Knific, professor.

Jazz students won seven awards last year and six awards in each of the previous three years. WMU's strong showing in the contest over the past several years places the University squarely among the top five award-winning programs in the world, says Tom Knific, professor of music and director of the WMU Jazz Studies Program.

"The results speak to the talent and hard work of the program's students and dedication of the faculty," Knific says. WMU is pushing 170 in total *DownBeat* awards. ■

JUST MARRIED again

WORLD'S LARGEST VOW RENEWAL ATTEMPT!

East Campus has always been a great spot for romance.
First kisses, engagements, and now–weddings!
In celebration of this, join us on the Grand Lawn of
Heritage Hall during Homecoming weekend,
October 8, 2016 as we attempt to break the
Guinness World Record for most vow renewals in one place.
Recommit to your sweetie and then watch the
Broncos row the boat to a Homecoming victory!

For more information and to register, please visit
MyWMU.com/Vows.

Protecting our

Porter

Sierra Porter has always been drawn to water, asserting that "as long as I'm in water, or around the water, I'm happy."

She must be happy a lot. The WMU sophomore is surrounded by water, living full time in Traverse City, a northwestern Michigan community with bays that flow into Lake Michigan.

"These waters mean so much to me. That's why I've never been able to fully leave this area. I live for freshwater. It's a way of life."

But more than just to play in, she has a strong inclination to be a freshwater steward.

"There's just so much impacting our Great Lakes right now. There's so much going into them as far as chemicals and pollutants," Porter says.

"It's important for our generation to protect (the Lakes)… Because once you wreck these watersheds and water systems, you can't go back. It's going to be out of our time, out of our children's time and maybe even our grandchildren's time before they'll be able to start to bounce back."

Porter is among the students that Northwestern Michigan College in Traverse City and WMU, as part of a collaborative degree program, are teaching to be the next generation of freshwater experts.

These students are preparing to address complex challenges related to sustainability of freshwater, not just in Michigan—whose Great Lakes contain 20 percent of the world's surface freshwater—but anywhere in the world, as well.

Overused groundwater, chemically contaminated water, water scarcity, limited access to clean water—United Nations' statistics on freshwater reveal there's no shortage of problems:

One in nine people worldwide does not have access to an improved source of drinking water.

Industry dumps an estimated 300 to 400 metric tons of polluted waste in waters annually, and 80 percent of sewage in developing countries gets discharged, untreated, into bodies of water, according UN Water, a UN inter-agency entity that deals with freshwater-related issues.

"Water is our most important asset by far, and a huge liability given what we are doing to it," says Dr. Charles Ide, a WMU biological sciences professor who teaches some freshwater science courses and researches chemicals that have contaminated water, wildlife and people.

"This is such a huge issue. And it's important that we train students who can make a difference in this area." ■

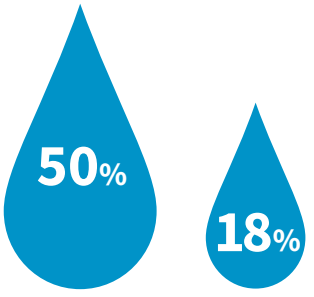
‘most important asset’

One in nine people worldwide doesn’t have access to improved sources of drinking water and **one in three** lacks improved sanitation.

WATER USE GROWING 2X RATE OF POPULATION

Nitrate from agriculture is the most common **chemical contaminant** in the world’s groundwater aquifers.

Increase in Water Withdrawal by 2025



Industry dumps an estimated **300-400 MT** of **polluted waste** in waters every year.

The biodiversity of freshwater ecosystems has been degraded more than any other ecosytem.

Source: UN Water

FRESHWATER **specialists**

WMU student and NMC staffer, John Lutchko, center, explains the finer points of piloting one of the community college's remotely operated submarine vehicles in the West Arm of Grand Traverse Bay in Traverse City. WMU senior Alexis Lee, left, has her hands on the controls as fellow student Sarah Ballard looks on. They used the sub to view quaggi mussels, an invasive species in the Great Lakes.

Using a remotely operated underwater vehicle, an ROV, John Lutchko helps explore the subsurface waters around Traverse City, including in Grand Traverse Bay, a bay of Lake Michigan.

"Research is so fascinating, and there's plenty to be done," says Lutchko, who this summer will be the first graduate of a joint degree program in freshwater science and sustainability offered by WMU and Traverse City-based Northwestern Michigan College.

The linked degrees, an associate from NMC that leads to a bachelor's from the University, prepare students to become the next wave of professionals who will solve problems related to freshwater quality, availability and use.

Lutchko has been a top student in both schools. This year, he was named WMU's environmental and sustainability studies Presidential Scholar, a designation that is the highest academic honor the University bestows on undergraduates. And after earning his associate degree, NMC hired him as its marine technology lab coordinator and primary ROV pilot.

"These two programs have been so engaging," he says. "Whether it's watershed science at NMC, where we do field work, or freshwater ecology, or (WMU Professor Charles Ide's class on Human Impacts on the Great Lakes), getting out and doing work. That's the way you learn for sure."

Viewing invaders

On a sunny Saturday morning in June, as part of the human impacts course, WMU students took turns learning how to pilot an ROV while aboard the Northwesterner, NMC's 56-foot research vessel.

Research and monitoring dives in Traverse City underscore what a gem Michigan's freshwater lakes are and, importantly, such excursions reveal some of the invasive species that threaten them, including quagga mussels, gobies and other invaders.

In the West Arm of Grand Traverse Bay, not far from the community college's Great Lakes Campus, students searched for the Nyord, a boat that sank in the 1970s.

Intently gazing at a screen that displayed live video from an ROV, WMU student Sarah Ballard followed Lutchko's directions for remotely "flying" the vehicle, her hands operating what looked like a joystick.

"Don't use the up thruster," Lutchko advised. "Thrusters kick up debris. Let it float up."

Ballard complied.

"Now go back and forth."

Soon enough, the murk cleared, uncloaking life some 50 feet beneath the surface of West Bay. Lutchko gestured to a tiny fish that darted into the frame.

"See the goby?"

"I see the goby… right… there," a rapt Ballard responded slowly, trying to discern shapes on screen.

Indigenous to the Black and Caspian seas, gobies are not welcome in Michigan's Great Lakes and inland waters, as these bottom-dwellers eat the eggs of native fish and compete with native species for food and habitat.

Dr. Hans VanSumeren, head of NMC's Great Lakes Water Studies Institute, explains to WMU students the workings of the remotely operated submarine vehicle shown in the foreground.

The point of viewing the shipwreck that day was to see firsthand the proliferation of quagga mussels, a habitat-destroying invader that students learned is profuse in the Great Lakes Basin. About the size of a quarter in adulthood, the bivalves came over in ballast water of transoceanic ships.

"These organisms have very few natural predators here and they just thrive," says Ide, the biological sciences professor who teaches the human impacts course.

Quaggas, and the also-invasive zebra mussel, filter feed, which increases water clarity. This may sound beneficial, or even benign, but clearing subsurface waters like this allows algae to grow at increasingly greater depths.

Students found that the Nyord is caked in quaggas, one example of a widespread problem.

"There's a quadrillion quagga mussels (in the Great Lakes Basin), and they're here to stay," Lutchko says.

"You can't just go and kill them all because you're going to kill a lot of other things in the process. There is nothing we can do; but we have to keep an eye on what's going on. That's where the monitoring comes in."

Holistic and hands-on

Like this weekend in Traverse City, along with classroom-based instruction, freshwater science and sustainability students get direct experiences in some of the ecosystems they are learning about and may go on to encounter in watershed management, environmental consulting or the other fields they will be prepared to pursue.

"Building a cohort of good scientists who have multidisciplinary skills is what this is all about," says Dr. Hans VanSumeren, director of NMC's Great Lakes Water Studies Institute and co-founder of the community college's freshwater studies degree, the first associate degree of its kind in the nation when it was established in 2009.

Several years ago, NMC and WMU officials began talks about joining forces in a program of study that could lead from a two-year degree at NMC to a bachelor's degree at WMU. The program launched in 2014.

"The program covers biology and ecology, but it's also got policy, data processing, oceanography, climate (science), business and communication. It's holistic. Industry wants people who know how to do a lot of stuff," VanSumeren says.

With its surrounding Great Lakes containing 20 percent of the world's surface freshwater, "Michigan would have to be the best place in the country, and maybe in the world,

to study freshwater," says Dr. Steve Kohler, professor of biological sciences and director of WMU's Environmental and Sustainability Studies program.

"One, there's the quantity. But the other reason is the diversity of systems. The diversity of types, both the lakes and rivers, is outstanding. You have different ecosystems to study. We can't show students tropical systems, but we can show them just about everything else."

Students who want to complete all of their freshwater science and sustainability studies in Traverse City may enroll at NMC and earn an associate degree, then transfer to WMU-Traverse City to complete the final two years of coursework required for a bachelor's degree.

Students also may enroll in the bachelor's-only version of the program offered on WMU's main campus in Kalamazoo.

A desire 'to keep fresh waters... fresh'

Taking Ide's class was an eye-opening experience for Sierra Porter, a sophomore majoring in freshwater science.

The course is based on Ide's years of research funded by Environmental Protection Agency grants. In addition to invasive species, his students learn about how pollutants, such as polychlorinated biphenyls—PCBs—in the Great Lakes and inland waters impact ecosystem and human health.

Each student had a capstone project; Porter's presentation was on persistent organic pollutants, such as PCBs. Though production of these industrial chemicals has been banned in the U.S. for almost 40 years, they persist in the environment.

"Now, more PCBs come into Lake Michigan from other parts of the world through weather," Ide says. "They come over the lake and get rained down. So, it's like a global problem."

PCBs have been found in animal tissue, including that of eagles, water fowl and game fish. The contaminant is one of the reasons state government issues advisories on how much and what type of fish are safe to eat.

As an example of just one ill effect, for a developing fetus, high concentrations of PCBs can interfere with receptors that tell the brain and muscles how to use calcium.

"If your brain isn't using calcium right, in human development, the brain doesn't develop properly," Ide explains

So, a child may be born with learning disabilities and low IQ.

"The PCB contamination has really opened my eyes," Porter says. "I want to get more in depth and learn about what other contaminants aren't being brought to the surface. Why aren't they being talked about? Why isn't anything being done about these?"

When she completes her degree, Porter hopes to "work toward keeping our fresh waters, just as they say, fresh.

"I'm not sure where that's going to take me in life, but being in science is always a thrill, and to study in this program has already given me many opportunities to meet other scientists with the same dream as mine." ■

For more information about freshwater science degree options, go to wmich.edu/academics/undergraduate/freshwater or contact Dr. Steve Kohler at steve.kohler@wmich.edu or (269) 387-2987, and NMC's Great Lakes Water Studies Institute at (231) 995-3333 or visit nmc.edu/water.

WMU biology major Zack Ladwig helps VanSumeren retrieve a submarine.

A history of **diversions**

Water abundance in the Great Lakes and St. Lawrence River Basin has long stirred envy in those who would like to divert this 'liquid gold.'

Since 1900, engineers have attempted to control the Great Lakes and St. Lawrence River Basin with huge navigation and hydroelectric power projects. These efforts have meant that moving water in one lake can impact the others—even if the change is only a few inches.

Macfarlane

Dr. Daniel Macfarlane, assistant professor of environmental and sustainability studies, specializes in the trans-border history of controlling water in the Great Lakes.

Macfarlane says the water abundance in the Great Lakes and St. Lawrence River Basin has long provoked envy from those outside the region who would like to divert this "liquid gold."

To prevent these diversions from happening, the Great Lakes-St. Lawrence River Basin Water Resources Compact was signed by the eight states of the region in December 2005 and put into effect in 2008. One key provision of the compact is that each state has veto power over any request for diversion.

The pact recently faced its first test when Waukesha, Wisconsin, a town outside the basin, formally requested diverting water from Lake Michigan. The community's groundwater is contaminated with radium.

In June, the eight states approved the Waukesha's request, a move that surprised Macfarlane, given Michigan's past history of denying such diversions.

And with this new precedent, some people worry that other requests will emerge from areas like the arid southwestern states and those in the Great Plains that rely on water from the diminishing Ogallala Aquifer.

"Many people are worried, but I personally don't think this is likely to open the door to many more diversion requests," Macfarlane says. "So few communities near the basin actually meet the compact standards, and unanimous approval is required from all Great Lakes states."

Water-management history

In 1985 the International Joint Commission reported on consumptive uses and the effects of existing diversions into and out of the Great Lakes system. It showed that irrigation had a greater impact on water supply than engineering diversions.

The study also concluded that climate and weather changes as well as precipitation, ice cover, evaporation and glacial rebound affect levels of the lakes far more than existing man-made diversions on the region's supply of water.

The water diversions of the 20th century have only slightly lowered the water line of the Great Lakes by a few feet, Macfarlane says.

However, he cautions against future diversions because there really isn't any surplus water. Instead, he suggests sticking to the compact, which seems to be a good safeguard against any large-scale diversions, and being vigilant about the unforeseen effects of climate change.

Although there were some water diversions in the 19th century, like the Erie and Welland canals, the 20th century has seen more massive works of water management. The first major diversion of the century was the Chicago Sanitary and Ship Canal, which reversed the natural flow of the Chicago River from Lake Michigan eventually into the Mississippi River for the city's sewage disposal.

"Water levels on the Great Lakes decreased by only a few inches, but the diversion cost states billions of dollars because of the impact on navigation, harbor and the hydroelectric industries," Macfarlane says.

As a result, Canada and the United States drew up and signed the Boundary Waters Treaty in 1909 to jointly manage their border water resources.

"This treaty was significant in that it pioneered anti-pollution obligations, provided a public-input mechanism whenever a change was proposed, and established the International Joint Commission to oversee these matters, which it still does to this very day," he says.

The treaty became the model for cooperatively handling environmental issues on borders and proposals of other projects like when two dams were built at the international boundary of the St. Mary's River, a border separating Michigan and Ontario, to regulate the flow of the river and Lake Superior.

The Niagara Falls water diversions were planned around aesthetic appeal and tourism dollars. Water was controlled upstream by turning it "on and off" at different times of the day in order to please tourists. In the 1950s, the Canadian "Horseshoe" Falls, the largest of the falls that make up Niagara, were reshaped for better distribution of flow and an unbroken crestline.

In 1969, the American Falls were "shut off" so that the removal of talus could be studied. This feat is scheduled to be repeated in the next couple years.

The diversions of Ontario's Ogoki and Long Lac rivers in the 1940s took water from the James Bay watershed and put it into Lake Superior to offset the Chicago diversion and to send more water to Lake Ontario, which produced more power at Niagara Falls.

But Macfarlane says the "big daddy" of all the water diversion projects was the construction of the St. Lawrence Seaway in the 1950s. It included three dams plus a gravity power dam, the second largest in North America at the time. This project required massive manipulation of the river and its environs—210 million cubic yards of earth and rock—that inundated 20,000 acres of Canadian land and 18,000 acres of American land.

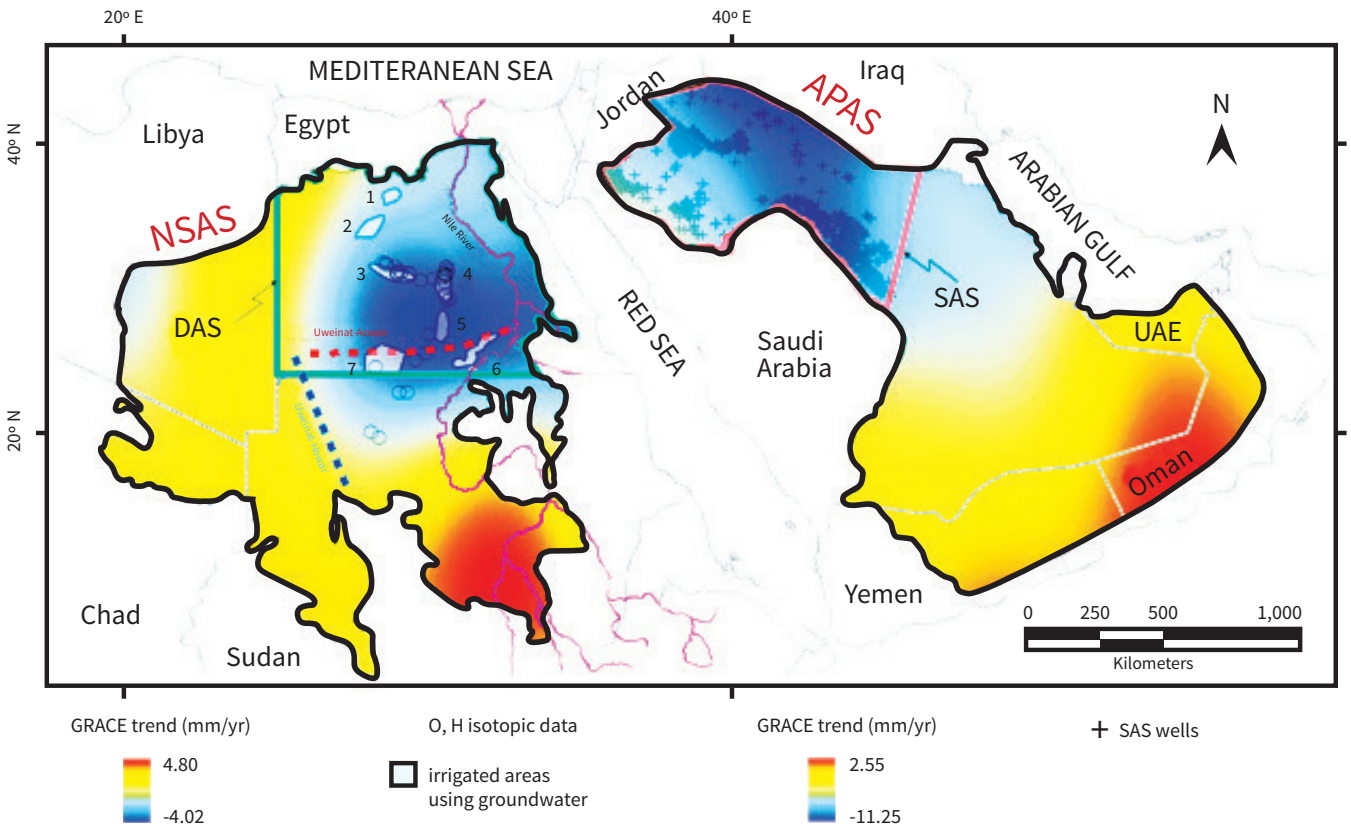
As a result of this project, Canada suffered the loss of 225 farms, seven villages, three hamlets, 18 cemeteries and 1,000 cottages while more than 60 miles of main east-west highway and main line railway were relocated.

A number of American channels had to be dredged to accommodate the larger ships that traveled through the seaway. The most important dredging took place in Lake St. Clair and the Detroit, St. Clair and St. Mary's rivers.

Macfarlane notes that dredging has likely had the greatest anthropogenic (human caused) impact of all these projects in terms of lowering water levels in the Great Lakes because of the "bathtub effect" due to increasing the volume of the basin with the same amount of water.

"History has shown that there are always unintended consequences that are often as bad or worse than the original problem they are trying to solve," Macfarlane says. "In some important ways we are only still learning how large systems like the Great Lakes operate."■

The watery view from 310 miles up



One of the world's largest aquifers, the Nubian Aquifer, is a source of water in one of the world's largest deserts, the Sahara. Measuring the water supply of such aquifers from satellites 310 miles above Earth's surface is one of NASA's greatest successes.

This feat of remote sensing also is proving to be an invaluable tool for hydrogeologists, including Dr. Mohamed Sultan.

Sultan, head of the WMU Earth Sciences Remote Sensing Lab and chair of the Department of Geosciences, is one of the few scientists in the world to use GRACE data to study groundwater in Africa.

GRACE, short for the Gravity Recovery and Climate Experiment, is a joint mission of NASA and the German Aerospace Center. It consists of two identical satellites that have been making detailed measurements of Earth's gravity field anomalies since their launch in March 2002.

Through the use of GRACE, Sultan conducts groundbreaking research related to observing the effects of climate change, managing water resources and monitoring international agreements that govern resource sharing. He is aided by a research team led by his post-doctoral research fellow, Dr. Mohamed Ahmed.

Over the past eight years, NASA has supported Sultan's GRACE research with nearly $900,000 in grants. In 2013, he also received $60,000 from the Saudi Geological Survey to assess groundwater resources across the Arabian Peninsula and another $27,000 this year from the National Authority for Remote Sensing and Space Sciences to sponsor four Egyptian researchers this summer who will learn how to use GRACE for groundwater exploration in their country.

"We've developed a reputation that we are the 'go-to' institution when it comes to GRACE applications in hydrology in Africa and Arabia," Sultan says.

Monitoring mass and water

Data from the GRACE satellites greatly aid scientists in studying the Earth's oceans, hydrologic systems and climate change. By measuring gravity anomalies, GRACE shows how mass is distributed around the planet and how it varies over time.

Sultan uses GRACE to measure the spatial and temporal variations in mass over Africa's watersheds and aquifers to assess whether these variations are caused by Mother Nature or by human activity.

Sultan's research team identifies areas that are getting wetter and those that are getting drier over time. They can determine which aquifers are being depleted by excessive extraction of groundwater and those that continue to be recharged at a near-steady rate.

Sultan, however, also makes a unique use of GRACE. He integrates its data with outputs of land surface models and observations from such traditional datasets and disciplines as geochemistry, geochronology, hydrology, surface runoff, groundwater flow modeling and field geology.

"Many geological researchers are focused only on abstract data obtained from GRACE while we provide more added value, applying a more integrated approach," he says.

Over the past eight years, Sultan has observed that many areas in western and central Africa are showing signs of increasing mass and wetness with time due to an unusually high degree of precipitation, a phenomenon he attributes to global warming intensifying Atlantic monsoons.

"We can verify what GRACE tells us by observing and measuring how precipitation levels have been increasing," he says. "This increase is related to the fact that as the oceans heat up, more moisture is put into the air, which creates clouds that move to coastlines, meet the mountains and ultimately causes precipitation."

East Africa is experiencing the opposite effect. Scientists say global warming is heating the Indian Ocean, producing more moisture than usual. But the patterns of precipitation are changing. Rain clouds are not moving toward the land but rather away from it. This change has created drier conditions in East Africa due to a paucity of rainfall.

'Policing hydrological systems'

Sultan also uses GRACE to understand and monitor the effects of manmade projects and activities. For example, satellites show that although rainfall over source areas of the Nile River remains unchanged, there is a significant mass increase in the source areas. The reason is that countries upstream have been building new dams or enhancing existing dams to collect more water.

"GRACE provides a way of policing hydrological systems that we never had before," Sultan says. "It can potentially be used to verify international agreements over the use of water resources, especially as water supply becomes more of an issue."

Case in point: Egypt and Ethiopia have been in intense negotiations over the Grand Ethiopian Renaissance Dam, a massive Ethiopian hydroelectric project now underway. The dam is expected to impound, or confine, 90 percent of the water that normally reaches Egypt from the Blue Nile, a tributary of the Nile River. The White Nile tributary is also a water source for Egypt.

If the reservoir behind the dam is to be filled in seven years, Egypt will be deprived of a quarter of its annual allocation from Nile waters. Egypt wants to prolong the time it takes to fill Ethiopia's reservoirs so that Egypt gets the water it needs downstream.

Whatever agreement is reached, GRACE can monitor and verify compliance.

Continued on page 32

The *other* potent **greenhouse gas**

Carbon dioxide is often discussed as the driving force behind global climate change.

Research has shown that excessive carbon in the atmosphere as a result of humanity's unrestrained penchant for burning fossil fuels is contributing to throwing the Earth's climate systems out of whack. And human activity has increased the warming effect of atmospheric carbon, according to climate scientists.

"We're dialing up Earth's thermostat in a way that will lock more heat into the ocean and atmosphere for thousands of years," says Jim Butler, director of the National Oceanic and Atmospheric Administration's Global Monitoring Division.

> "Understanding how water moves in the changing climate is about the most important question there is."
>
> **— Dr. Todd Ellis, assistant professor of geography**

But there's another critical atmospheric gas that is made much more potent due to that locked-in heat, affecting where clouds rain and how often, leading to flooding in some places and drought in others.

The increased concentration of atmospheric carbon just happens to be the start of the climate change process, explains Dr. Todd Ellis, assistant professor of geography and an expert in atmospheric science, with specialties in weather research and climate education.

"Water vapor—the gas form of water—is a way more potent greenhouse gas than anything that comes out of the fuel we use," he says.

This doesn't take humanity off the hook for creating a global climate conundrum; human activity just started an unfortunate chain reaction.

As Butler remarked, extra carbon dioxide in the atmosphere also puts extra energy into the Earth's surface, warming the planet's crust and its huge store of surface water. The Earth earned its colloquial moniker the Blue Planet because of this huge store of water; some 70 percent of the surface is covered by it.

"When the surface is a little warmer and the air near the surface is a little warmer, more water vapor can exist there," Ellis says. "We call it the water vapor feedback. A little change in the things we control create much bigger changes in the amount of water vapor.

"So, we care about the greenhouse gases we make. But it's the effect of those greenhouse gases on the big one—water—that tends to drive energy. It also changes where it precipitates and how often, pretty substantially in fact."

Rising waters

By way of example, for the past several years, parts of Texas, namely the Houston area, have dealt with devastating floods. During the spring of 2015, rain came down in torrents, resulting in property damage in wide swaths and even fatalities.

Again this past spring, torrential rain doused the region with similar results.

In Harris County (Houston is the county seat), 240 billion gallons of rain dropped onto the community during one 24-hour period in mid-April, according to the Harris County Flood Control District.

After storms waylaid the area for several days, Harris and surrounding counties were deemed a federal disaster.

While one can't point to a single weather event like this one and conclude it is the result of climate change, patterns matter, Ellis says.

"Houston has had a bunch of these (rain events) over the last decade, decade and a half… That is something we can point directly to climate change and its impacts on water vapor. You put more water into the atmosphere, and then the right system comes along, and it's got all of that extra water to tap into and turn into rain."

Harris County is in southeast Texas, just 50 miles from the Gulf of Mexico. As a result of its proximity to the gulf, there is a ready supply of surface water to be converted to water vapor, and so the air is often near its maximum limit of moisture, Ellis explains.

"The primary thing that defines that upper limit (of water vapor) is the temperature. As the atmosphere warms, that limit is just going to keep going up, increasing the amount of water vapor that can hang around in the atmosphere waiting for some system to come along and tap into it."

So that's a wet area getting even more so. But how does climate change result in arid places becoming more parched?

Think back to elementary school Earth science lessons on the hydrologic cycle. In this process, water evaporates from the surface, moves through the atmosphere, condenses as clouds and returns to Earth as precipitation. But as the climate warms, studies have shown that the water cycle slows down.

"If you could put a tracking tag on a single water vapor molecule and watch it go through that whole cycle, you'd see that for a doubling of carbon dioxide, (the molecule's) journey is slowed by a few days," Ellis explains.

So, a process that would normally take seven days, for instance, could take nine or 10.

While that delay doesn't seem very substantial, Ellis says "the impact is essentially how easy is it for us to see rain form and when it does form, how much rain falls.

"When storms occur, more rain falls, but that, in turn, deprives other areas from accessing that water. So it has two impacts put into one simple phrase: The wet areas get wetter and the dry areas get drier."

While Houston's water-related woes offer an example of what can happen with an overabundance of precipitation, other areas of the western United States have suffered from ongoing dry conditions.

In recent months, Lake Mead, the largest man-made reservoir in the United States when at capacity, hit its lowest level since it was created some 80 years ago. Thanks to about 16 years of drought coupled with demand for water, the lake was at 37 percent of its capacity in May, according to the U.S. Bureau of Reclamation's Lower Colorado Region.

Formed by the Hoover Dam, the reservoir serves Arizona, California and Nevada. As this resource shrinks, the impact is felt by people, animals and business, including the agricultural industry.

Follow-on effects

There are myriad ways both scarcity and excessive water lead to suffering and economic stress.

"Those stresses hit all of us, but it's going to hit the people who are already at a socio-economic disadvantage first because there's no safety net. That works both within our own society and when looking at countries as a whole," Ellis says, pointing to the crisis that led refugees from Syria to flee for safe havens in Europe.

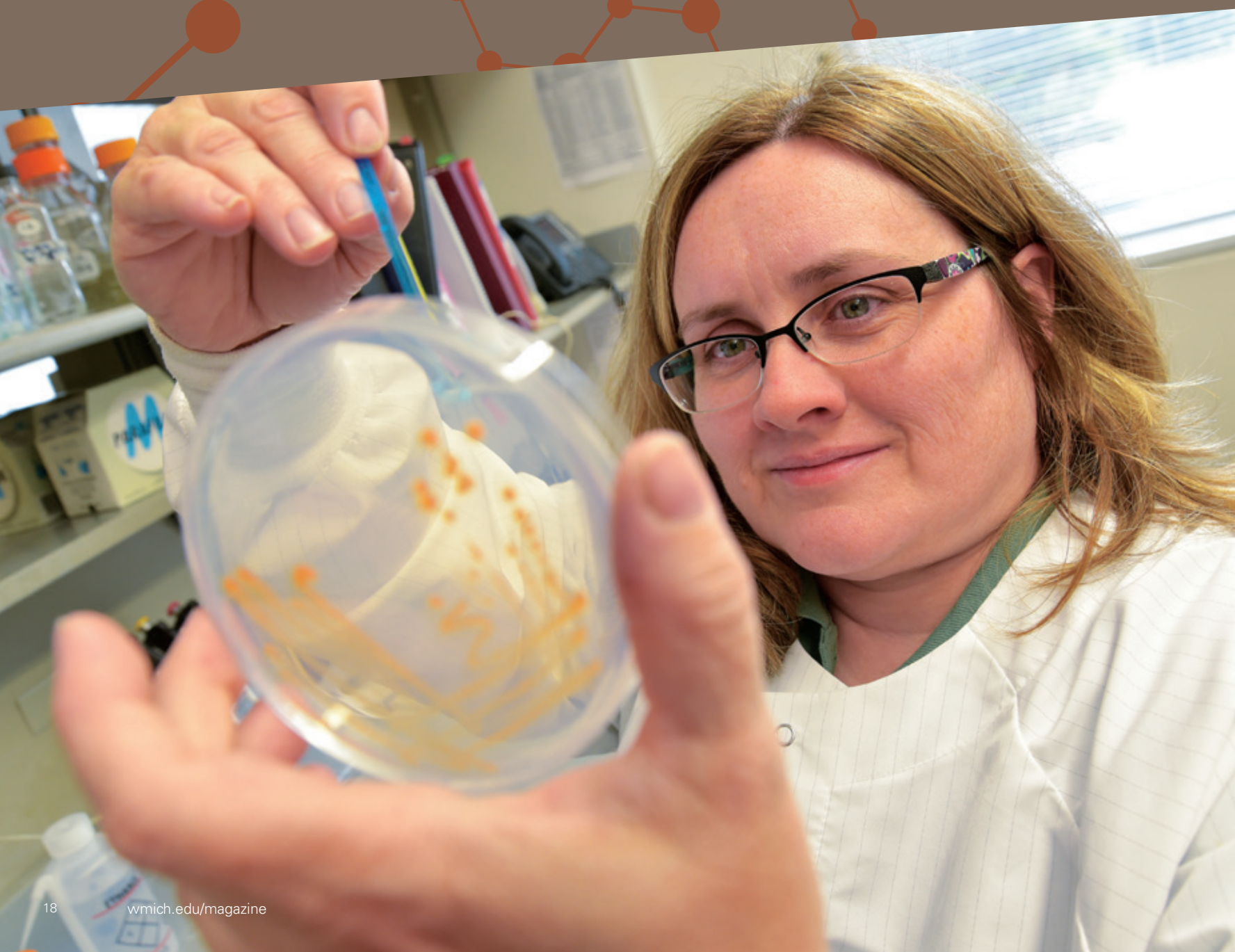
"While the refugee crisis around Syria has more to do with war than it does water, that is a part of the world that has had civilizations collapse because of lack of rainfall in the past…

"Pakistan has had the opposite situation, really significant flooding, and they don't have the infrastructure to deal with it either. So it really starts to bleed into some significant geopolitical questions in places where you don't want to have those kinds of extra stresses," he says.

Ellis opines that in a changing climate, understanding how water moves is one of the most important questions there is.

"There are a lot of important questions to be asked about climate change, but water is a living resource for all of us. And none of us as humans has figured out how to live without it yet." ■

Multitalented microbiology student—
highly lauded for her scholarship



Carol Beaver has long been the inquisitive sort, a creative mind fueled by versatility and the notion that there is always something new to discover.

Her past professions speak to this. After earning a music degree, the viola player taught general music in an elementary school. For quite a different challenge, she later joined the U.S. Marine Corps, working as an aircraft mechanic on combat jet ejection seats.

"Maybe because I was more interested in science and how things are put together," she says.

In ensuing years, Beaver focused on mothering three children and managed a restaurant.

But she longed to return to school and at WMU found a new passion—environmental microbiology—while completing a biomedical sciences degree.

"I think I became interested in microbiology because there are a lot of organisms that are not known and named, and I figured there's a good chance that I would find something new," she says.

Beaver now is in the homestretch of completing a doctorate at WMU and already is distinguishing herself as a scientific investigator, racking up a series of awards.

Her latest accolades include being named a Gwen Frostic doctoral fellow for 2016-17 and receiving the MPI Outstanding Graduate Research Award. And the Department of Biological Sciences nominated her for the 2016 department-level Graduate Research and Creative Scholar Award, sponsored by the Graduate College and the Graduate Studies Council.

"Western has been a great place to be," Beaver says. "I've been given opportunities here that I wouldn't have had going somewhere else. For one, there aren't many people who work in biogeophysics. The whole field is new."

In her doctoral studies, Beaver has been conducting research at the famed Bemidji, Minnesota, oil spill site with biological sciences Professor Silvia Rossbach and Dr. Estella Atekwana. Atekwana is a former WMU professor who pioneered the sub-discipline of biogeophysics and is today an Oklahoma State University geological researcher.

Biogeophysics is concerned with how microorganisms, such as bacteria, influence geological material, such as sediment and rock. Only during the last few decades have scientists recognized this interaction.

Rossbach's and Atekwana's labs collaborate in research on the Bemidji oil site, a forested area that was heavily contaminated when a pipeline rupture in 1979 caused more than 100,000 gallons of oil to surge into the land.

Because the oil leaked into what is a remote area near Bemidji and does not impact community drinking water, the petroleum was not completely cleaned up so that scientists could study how such oil spills are naturally degraded by microorganisms. What U.S. Geological Survey and academic researchers have discovered on site has been used to address oil spills around the globe, according to the USGS.

"Western has been a great place to be. I've been given opportunities here that I wouldn't have had going somewhere else. For one, there aren't many people who work in biogeophysics. The whole field is new."

—Beaver

WMU researchers, including Beaver, are working to contribute to that body of knowledge.

"I find it very interesting what microbes can do to the environment," Beaver says. "I think that for a lot of the problems we have today, some of the solutions might be found in encouraging or manipulating microbes to deal with some of these environmental situations.

"With an oil spill, a lot of times, the only way you can fix it is by the microbes breaking it down and degrading everything and turning it into carbon dioxide, or methane, to get rid of the contamination," she explains.

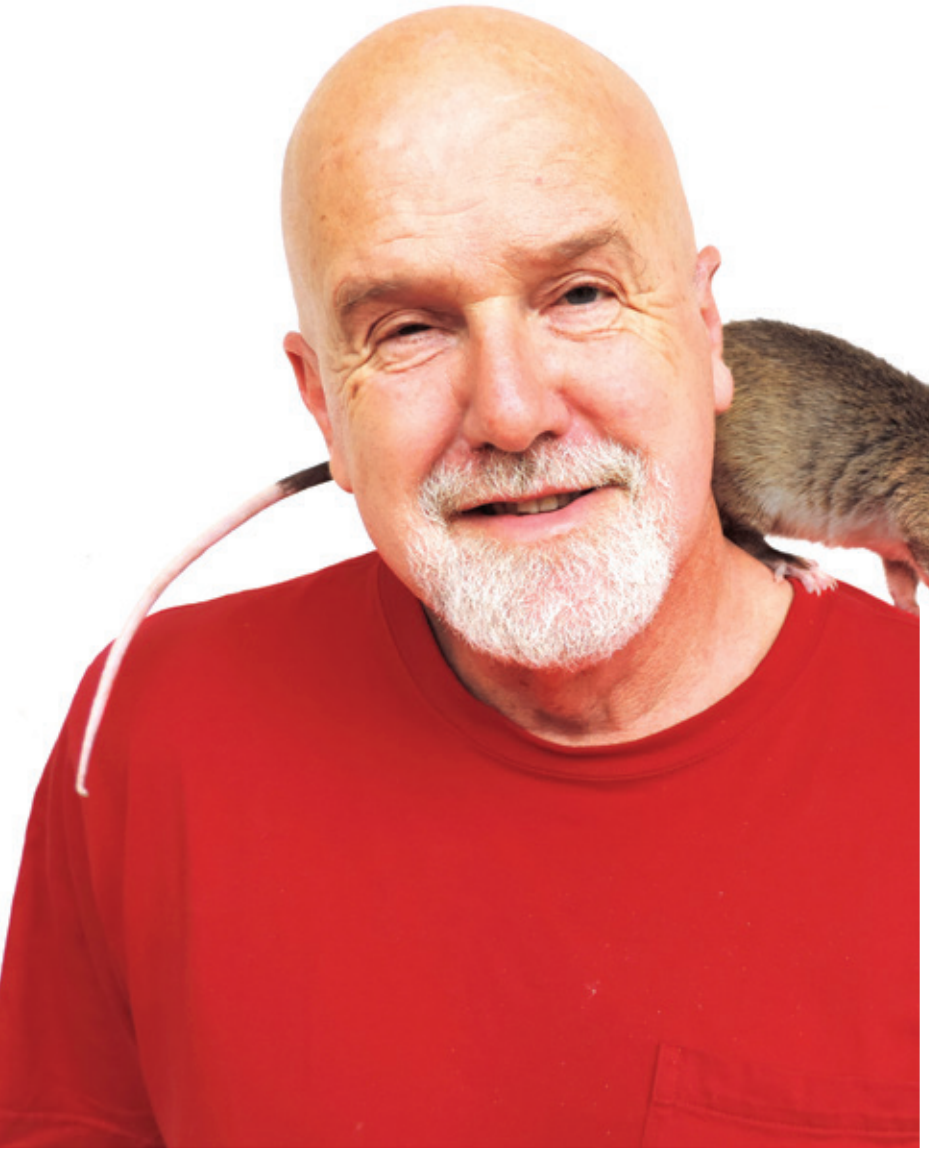
Her research involves analyzing how this natural remediation affects certain geophysical characteristics of the surrounding environment.

"And if they do affect them, what geophysicists could do is put probes in the ground and use them to monitor the bioremediation. It would be a lot cheaper and a lot less invasive to stick a probe in the ground and watch it all the time versus continually digging long cores."

Rossbach, Beaver's graduate advisor and mentor, says her student "has really achieved at a high level."

"Carol's research will have great impact on not only one, but two disciplines, microbiology and geophysics." ■

Work with **'HeroRATs'** yields researcher humanitarian award



The American Psychological Association has honored Dr. Alan Poling with its 2016 International Humanitarian Award for the psychology professor's work with land mine- and tuberculosis-detecting African giant pouched rats.

The award lauds "extraordinary humanitarian services and activism by psychologists, including professional and volunteer work conducted primarily in the field with underserved populations," according to the APA.

Long experienced in researching a variety of animals as a behavior analyst, with expertise in how creatures learn, Poling has for years contributed this knowledge to APOPO, a Belgian humanitarian organization based in Morogoro, Tanzania.

APOPO, an acronym for a Dutch name that translates in English to Anti-Personnel Landmines Detection Product Development, teaches and engages African pouched rats—dubbed HeroRATs—to identify TB in laboratory samples and to safely recognize the presence of mines buried to kill and maim.

The rats offer a cost-effective means to pinpoint these two scourges in countries that are low-income and low-resourced, including in parts of Africa and Southeast Asia.

APOPO's founder, Bart Weetjens, credits Poling for scientifically substantiating the rats' reliability as mine and TB detectors, helping to open the way for their widening use in life-saving work.

Impressed by his creative application of behavioral principles, Dr. Amy Damashek, one of Poling's colleagues in WMU's psychology department, nominated him for the APA honor. He will be formally fêted in August at the association's annual convention.

"His work is having such an important impact on the lives of people in developing nations," Damashek says. "That's why he is winning this award from the American Psychological Association, because his research is doing so much good and has the potential to save many, many lives."

It was more than seven years ago that Poling responded to APOPO's call for research help.

Weetjens says his organization had successfully trained the African pouched rats and had confidence in their detection skills, but realized they needed more published, research-based verification to demonstrate their value.

Trained African giant pouched rats have become invaluable in land mine eradication. The rats, which weigh up to 3 pounds, can roam suspected areas without triggering a blast. They detect mines with a keen sense of smell and paw the soil to indicate an explosive.

"Very little rigorous science had been published on the subject," Weetjens says of the period prior to Poling joining APOPO's work.

For his part, Poling was interested in a new challenge, in experiencing Africa and, as he learned about them, helping to address two menaces that harm and kill thousands annually around the world.

"Tuberculosis amazed me. Before I got involved with this, I thought tuberculosis pretty much went away 100 years ago, but it's horrific," he says. "About one person in three worldwide has been exposed to it. If your immune system is going well, you're OK. But if anything compromises your immune system, it's a horrible disease."

> "If APOPO's HeroRATs were finally accepted as a reliable detection tool, credits go to Dr. Poling and his researchers."
>
> **—Bart Weetjens, founder of a humanitarian organization that trains rats to detect land mines and tuberculosis**

And land mines, according to the United Nations, kill 15,000 to 20,000 people annually.

"I thought if I could take the skills I've acquired and do something in those domains, then that would be worthwhile," he says.

Over the years, the professor and his students have developed ways to evaluate how well the rats perform at finding mines and other explosives. And they test the animal's accuracy at detecting tuberculosis.

"We also try to sort out ways to make them better (at their tasks) or to help other APOPO staff devise new humanitarian applications for them," Poling says.

The professor has a lot of respect for the rodents' services and what they can do with their lithe little bodies and sensitive noses.

"They're remarkable in their physical abilities. They climb well. They dig well. They're quick. And they learn readily.

"They have some behavioral characteristics that makes them useful for the kind of work that we're doing. They don't bond with people. And they'll work for a long period for preferred foods without being very food deprived, so we can keep them healthy," he says.

The creatures, which stand between about 10 and 18 inches tall and weigh up to 3 pounds, have helped diagnose thousands of cases of TB and helped clear Mozambique of all its land mines.

But in APOPO's early years, not everyone appreciated the rodents' detection skill.

In 1998, Weetjens says he started APOPO with a strong sense of compassion for communities living in fear of subterranean explosives left behind in the wake of conflict. He had kept rats as pets and based on what he knew about them, felt rodents could be employed in mine detection without risking their safety.

"Their small weight allowed them to roam freely over a suspected area, searching for explosive devices, and indicating their positions by scratching the soil above the source of the smell," he explains.

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ADVERTISING multiracial identity

What happens when ads transcend BLACK and WHITE?

In 2013, General Mills released a Cheerios commercial that featured an interracial couple and their biracial daughter.

The ad, which aired for millions to see during the Super Bowl that year, was strongly criticized by some for its depiction of a mixed-race family. Instead of backing down, General Mills doubled down, releasing another Super Bowl ad in 2014 featuring the same family.

The commercials portrayed mundane moments in household life, but they represented a revolution.

Individuals who self-identify as mixed race are a growing demographic in the United States, yet prominently featuring a mixed-race couple with multiracial offspring is a sharp departure from norms in advertising imagery, according to a WMU researcher.

In a study of 65 ads that depicted multiracial women, for example, Dr. Robert Harrison, associate professor of marketing, found that few advertisements represented multiracial women interacting in the context of their families, their workplaces or in a social setting.

He and his research collaborators looked for all those roles, but "we came to find out that they didn't have any roles," says Harrison, whose latest research focuses on how

multiracial individuals are portrayed in ads and how those individuals perceive depictions of themselves.

Even though multiracial consumers represent some $148 billion worth of purchasing power, according to the Selig Center of Economic Growth, this has been largely ignored by the advertising world, Harrison says.

Still, depictions of multiracial men, women and families are seen as paving the way for better, more inclusive ads, pushing the reset button on conventional advertising boundaries. Advertisers are beginning to appreciate that by ignoring a growing demographic, they may be leaving money on the table, given the buying power of multiracial consumers.

Moreover, Harrison adds, the Cheerios commercials, and advertisements of their ilk, also are significant to many because they reflect the fact that interracial families exist. While producing an ad is essentially about producing profits, by running commercials that reflect racial diversity in a society that wrestles with racial prejudice, marketers are "kind of doing civil rights without trying to," Harrison says.

"Even though it's not altruistic, as ad agencies) were going after a $148 billion industry that was being ignored, it still made a very poignant point about depicting interracial families."

Ads and racial identity

Harrison says he began exploring questions of multiracial identity as his young daughters, who are of mixed race, began asking about their own racial identities. He wanted to offer them answers and found he stepped into a rich research topic.

He is joined in this research by Dr. Kevin Thomas, assistant professor of advertising at the University of Texas, and Dr. Samantha Cross, assistant professor of marketing at Iowa State University.

In their investigation, the researchers asked people who self-identified as multiracial to view ads and describe what the ads meant. They were interested in how multiracial consumers saw themselves and also in their perceptions of how marketers regarded them.

As they gathered stories and observations from respondents, their research topic evolved. They began studying how identity affects consumption and how multiracial individuals grow into being who they are.

Using ads featuring multiracial models, the research team planned to create a narrative of what a multiracial woman's life looked like in commercial portrayals of family, social and professional roles in ads. However, the results were less than ideal.

"We were looking for all of these roles to tell the story and we came to find out that they didn't have any roles. They were just pictures of faces, headshots," Harrison says.

"I showed (research subjects) ads and then they would talk about the ads and then, all of a sudden, they would end up talking about their lives. They'd talk about their journey to understanding their 'multiracialness.'"

Study participants talked about feeling as though they lived in two worlds, especially when it came to interacting with family and friends.

Of family, one respondent said, "On the black side of my family, I'm always the white one and on the white side of my family, I'm always the black one. I'm never the mixed one."

Harrison says this shows how difficult it can be for multiracial individuals to come to grips with their identities when they are often viewed as being one race or another, neither of which encompasses their entire identity.

On fitting in with friends, many respondents told researchers that they "use[d] clothing and brands to highlight ethnicity," and would wear different styles depending on the race and ethnicity of the friends with whom they were socializing.

But, according to Harrison, multiracial identities are changing because people are no longer forced to identify with one race over another. This is even supported by policy changes, such as when the U.S. Census Bureau, in 2000, began allowing individuals to identify as multiracial.

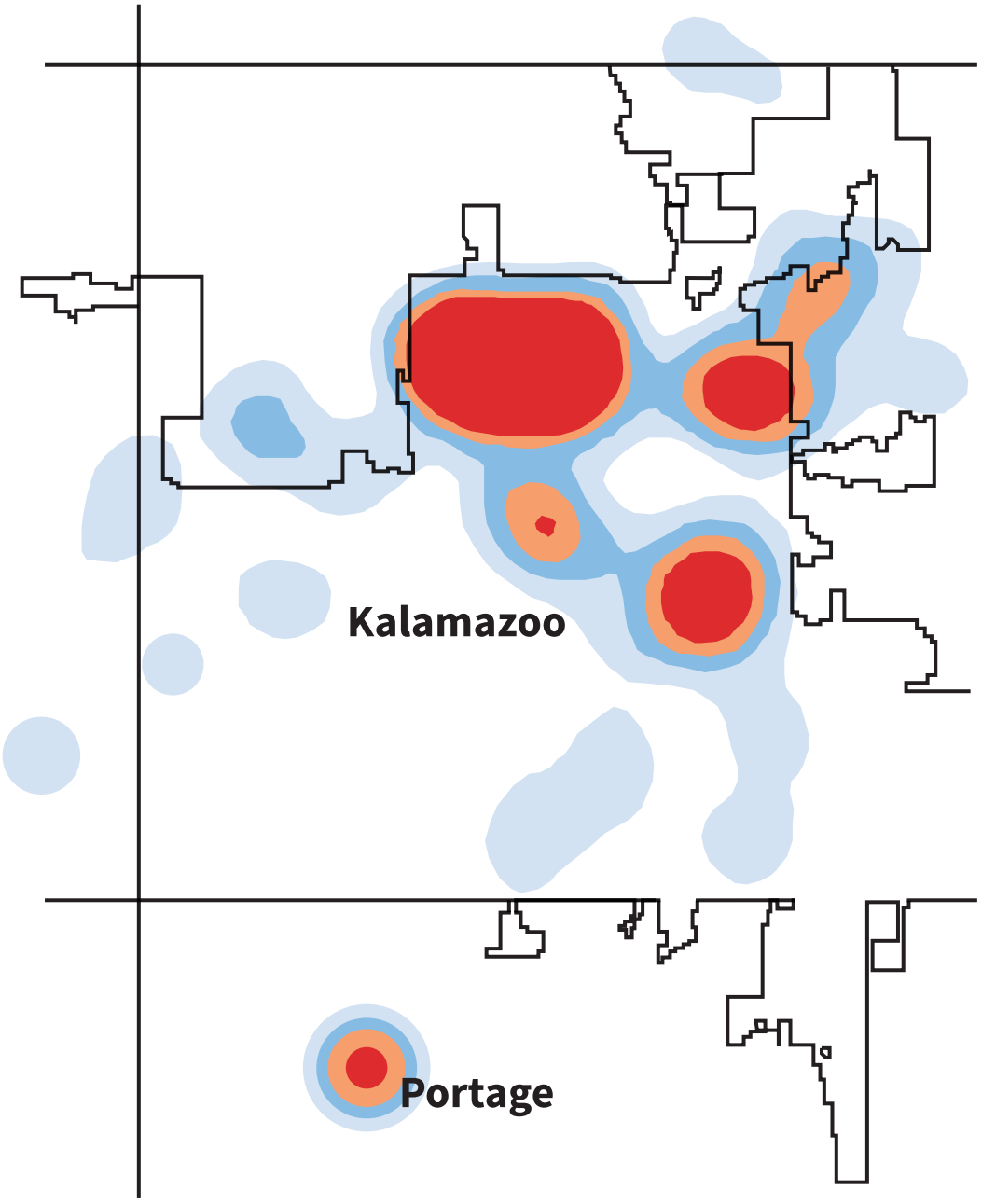
Following suit, advertisements are now becoming more diverse, which means multiracial individuals are more apt these days to see imagery that reflects the diversity they bring to society.

"They come to find that their uniqueness is something to embrace," says Harrison.

The team's research has thus far been well-received, resulting in a best paper award at a national conference, as well as a book chapter and journal publication. ■

WMU's 'Health DReAM' team

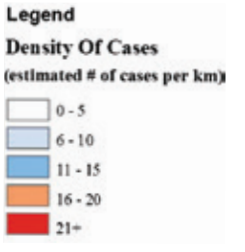
Using epidemiology, geography and statistics for communitywide well-being



Baker

Curtis

Paul



The cholera outbreak in London in 1854 is a classic case study of how epidemiology—the study of human health at the population level—benefits from cross-collaboration with other disciplines to respond to public health crises.

As the cholera outbreak ran rampant in London in the 19th century, Dr. John Snow studied where people afflicted resided and where they secured water.

From his analysis of geography and the habits reported by affected families, the physician isolated the source of the outbreak to contaminated water secured from a specific water pump. Snow obtained permission from the city to remove the water pump handle and thereby shut off the supply of contaminated water, helping to end the cholera epidemic.

Snow, known as the father of epidemiology, used mapping combined with other data sets to isolate the source of the outbreak. For his innovative mapping methods in the London calamity, he also is considered the father of medical geography.

Fast forward to the 21st century in Kalamazoo where the Health Data Research, Analysis and Mapping Center—the HDReAM Center—at WMU is using those same principles, aided by modern techniques, to map local health problems and improve community well-being.

As co-directors of HDReAM, Drs. Kathleen Baker, associate professor of geography, Amy Curtis, professor of interdisciplinary health sciences, and Rajib Paul, associate professor of statistics, combine their distinct specialties to uncover health trends in communities.

The intention is to help inform public health interventions, programming and the provision of medical services.

"As the health care providers for a community, you want to make sure you are putting the educational programming and resources where needed," says Curtis, a former epidemic intelligence service officer for the U.S. Centers for Disease Control and Prevention.

But how can a community be sure it is properly pinpointing its resources to address disease? Health mapping offers an answer.

The team's intention is to statistically prove where problems are, revealing significant patterns. But more than that, Baker says, "we want to analyze those patterns as scientists and make recommendations based on our analysis. This process allows us to address the community problems that are most significant.

"One of the foundational rules of geography is that if we can visualize data spatially, it makes more sense to us," Baker explains. "When we see patterns on a map of a place we know well and overlay those patterns with data that addresses issues of concern, everyone involved starts to understand the relationships among the data."

"For example," she says, "we can examine socioeconomic data like education, income, percentage of young people, racial and ethnic diversity, employment and underemployment patterns for the county; then we can start to overlay patterns in local health concerns like the prevalence of sexually transmitted infections or the health of newborns.

"We have a real focus on improving our community," Baker says. "We use the latest geographic information science and spatial statistical techniques with the data that's right here, answering questions that are critical to residents."

Students who train with the HDReAM researchers are learning to serve the community while practicing and perfecting skills in their academic disciplines.

Statistician Paul, the third research collaborator completing the team, explains that another important aspect of their work is to identify geographic disparities in disease as well as utilizations of health services by specific populations or communities.

The Kalamazoo Health and Community Services Department has been a community partner in HDREaM since its beginning five years ago. Working with officials from both Kalamazoo and Calhoun counties, HDReAM's experts have access to data from the Michigan Disease Surveillance System and vital records.

"Our goal is to identify the geographic disparities so that appropriate policies and regulations can be implemented for improvement of our community health."

—Paul

Paul takes the data and employs Bayesian and spatial statistical models for analyzing secondary data that comes from the Michigan Department of Health and Human Services and from two Kalamazoo-area hospitals, Borgess Health and Bronson Methodist Hospital.

"Our goal is to identify the geographic disparities so that appropriate policies and regulations can be implemented for improvement of our community health," he says.

The researchers say that communities are increasingly using data to help craft policy and drive decisions regarding health to ensure effective use and application of resources.

In a project for the Battle Creek (Michigan) Community Foundation, the mapping center gave the foundation some baseline measures, including low-birth-weight babies, sexually transmitted infections and public health program coverage. This evolved into a project with Blue Cross Blue Shield to create a website template to disperse such information.

"It's a template for how a university and a health department can work together collaboratively to analyze and disseminate information, in this case in the form of a website, about where there are risk factors, where current resources are and where current outcomes occur," Curtis explains.

If the data reveal, for instance, hotspots for sexually transmitted infections and unfavorable birth outcomes, "we might want to do a program that touches on both avoiding STIs and also improving birth outcomes."

This project and others go to show how combining the sciences of epidemiology, geography and statistics can make a tangible impact on community well-being. ■

Research file: Then and now

Taking history teaching ‘way beyond textbooks’

More than a decade ago, WMU’s Department of History received the first of four federal grants of nearly $1 million each to help teachers in southwestern Michigan improve U.S. history instruction in their classrooms.

The three-year grants were part of the Teaching American History Initiative developed by now-deceased West Virginia Sen. Robert Byrd and administered by the U.S. Department of Education.

The goal of the initiative was to improve the teaching of U.S. history at the elementary, middle and high school levels. Nationwide, the program was a $1.3 billion effort to build community partnerships that provided quality instruction for history teachers.

> “Teachers’ response to the workshops was enthusiastic and appreciative. They learned some new methods of teaching that moved them way beyond textbooks.”
>
> **—Dr. Wilson “Bill” Warren, professor and associate chair of history**

WMU received more of these grants than any other university in Michigan.

Some 13 years later, the University’s work with local teachers continues to pay dividends for K-12 students in classrooms throughout the area.

Eight WMU historians, and six not affiliated with the University, led summer institutes for 400 teachers over the course of four grants that were awarded between 2003 and 2009.

The institutes provided authentic historical training with hands-on activities that focused on actual artifacts from a given historical time period rather than more traditional teaching methods such as lectures, worksheets and online technology-based curricula.

“Teachers learned content from historical experts as well as methods of involving their students in research projects that used primary sources and archives,” says Dr. Wilson “Bill” Warren, professor of history and associate department chair.

“Many teachers had little background in history, so the initiative gave them an opportunity to develop their own knowledge and skills by working side by side with real historians.”

Warren directed the grants in partnership with the Kalamazoo Regional Educational Service Agency; the Kalamazoo Valley Museum; and WMU’s Department of Teaching, Learning and Leadership, as well as three Michigan organizations, the Sojourner Truth Institute in Battle Creek, the Henry Ford Museum in Dearborn, and the Gerald Ford Presidential Museum in Grand Rapids.

By taking part in the program, teachers earned professional development or graduate credit as well as stipends. Some teachers used their stipends to underwrite field trips to museums or archives for their students, a particular boon to schools that were unable to offer such activities because of budget cuts.

“The teachers’ response to the workshops was enthusiastic and appreciative,” Warren says. “They learned some new methods of teaching that moved them way beyond textbooks, teaching scripts and learning objectives that have become common in the present-day standards-based curriculum.”

Though history education may be given short shrift in schools because reading and mathematics are priorities for both the state’s core curriculum and testing purposes, Warren notes that historical thinking promotes important literacy skills.

“Kids love history in the lower grades. They find it as interesting as the stories they read in their literature classes. Unfortunately, history is not part of the central curriculum, so they are steered away from it. But historical literacy is all about summarizing, inferring and comprehending written materials—all very important reading skills.”

Learning history teaches students about how and when things happen and why they are important.

“Chronological thinking is very difficult, and without some background in history, students can’t learn to think about change over time,” Warren says. “You just can’t ignore these ways of thinking because they influence our lives and our culture. If you

are insensitive to them, you will not be able to understand our world. Such understanding is essential to good citizenship and democracy itself."

Just as the history initiative armed K-12 teachers and their students with more knowledge and skills, it also had a positive effect on the professors who presented the workshops, especially as they discovered more about the world of public education.

"We live in an ivory tower, to be sure," Warren says. "Interacting with the teachers allowed us to see the real world of K-12 education and to see the dedication of its teachers. We forget what it takes to teach a modern-day classroom, even though most of us have or have had children in schools. We all gained a lot more respect for teachers as a result."

Another significant outcome of the initiative was WMU's sponsorship of National History Day. Since 2015, WMU has invited area teachers to bring their classes to campus to compete in an academic competition for students in grades 6-12.

National History Day started as a local program at Case Western Reserve University in 1974 and grew to involve more than half a million students across the country. Students construct their entries as individuals or a group in one of five categories: documentary, exhibit, paper, performance or website. They then compete in a series of contests—at the individual school, district and state levels—to proceed to the national contest.

"History Day is so much better than Quiz Bowl," says Warren, "because students do projects rather than just recall facts on a variety of academic subjects."

The history initiative also resulted in a book. Warren; Dr. James Cousins, WMU history professor and an associate dean of the College of Arts and Sciences; and Dr. Gordon P. Andrews, Grand Valley State University professor, together produced "Collaboration and the Future of Education: Preserving the Right to Think and Teach Historically."

The subjects of the book were teachers from the Portage Public Schools, a community south of Kalamazoo, who reflected on historiography.

Historiography focuses on how historians study a topic using sources, techniques and theoretical approaches. Traditional historiography features political and economic history while newer approaches include social and cultural history. The intention behind teaching students historiography is to pique their curiosity and provide them with deeper insights into the discipline of history itself.

"Once teachers were given the freedom to engage their students in authentic historical exercises, then products and processes associated with the standards-based curriculum were no longer albatrosses around their necks," Warren says. "There are no substitutes for teachers' disciplinary knowledge and skills or the 'craft approach' to teaching history."

The craft-based approach helps teachers think about and arrive at insightful solutions to some of the most pressing problems facing history education. For example, craft-based teachers attend to cues in the classroom environment. If a lesson is progressing well, the teachers continue along the pathway they charted. But, when teachers intuit that something in the classroom environment has the potential to derail instruction or learning, they adjust accordingly in order to keep instruction and learning securely on track.

"Once teachers were given the freedom to engage their students in authentic historical exercises, then products and processes associated with the standards-based curriculum were no longer albatrosses around their necks."

—Warren

Craft teaching takes an incredible amount of time, patience, and practice to learn, Warren says. But this commitment of time and reflective thought makes it possible for good teachers to promote positive instructional and learning outcomes and avoid disasters.

Rick Searing is a history teacher and head of Portage Northern High School's International Baccalaureate program, a challenging program of study that offers high school students advanced curriculum. Searing was one of the hundreds of teachers to benefit from WMU's history initiative.

"The Teaching American History Initiative has provided a wealth of primary resources and teaching ideas that I have been able to incorporate into my IB History of the Americas course at Portage Northern," Searing says.

"The focus on authentic material and bringing new scholarship into our high school classrooms has impacted our students positively and has allowed them to be more prepared for success in college coursework and beyond." ■

Researcher's study shows that **virtual, blended schools struggle**

Full-time online schools and blended learning schools show outcomes that are consistently below traditional public schools, according to a report co-authored by a WMU researcher.

"Although increasing numbers of parents and students are choosing virtual or blended schools, relatively little is known about the inner workings of these schools," write Dr. Gary Miron, WMU professor of educational leadership, research and technology, and Dr. Charisse Gulosino, assistant professor of leadership and policy studies at the University of Memphis.

"Evidence related to inputs and outcomes indicate that students in these schools differ from those in traditional public schools. The school performance measures for both virtual and blended schools also indicate that these schools are not as successful as traditional public schools."

Nevertheless, their enrollment growth has continued.

Miron and Gulosino's "Virtual Schools Report 2016: Directory and Performance Review" was released by the National Education Policy Center, whose mission is to produce and disseminate high-quality, peer-reviewed research to inform education policy discussions that are based on sound evidence.

About the report

The researchers' report provides a detailed census of full-time virtual and blended schools, including student demographics, state-specific school performance ratings and a comparison of virtual school outcomes with state norms.

Full-time virtual schools deliver all curriculum and instruction via the internet and electronic communication, usually asynchronously with students at home and teachers at a remote location. Blended schools, combine traditional face-to-face instruction in classrooms with virtual instruction.

Miron notes that "large private education management organizations dominate the full-time virtual sector and they are increasing their market share in the blended school sector."

The growth of both sectors has been assisted by vigorous advertising campaigns, corporate lobbying and favorable legislation. Districts are opening their own virtual and blended learning schools, although these are typically small and with limited enrollment relative to charter-operated virtual and blended schools.

"Measures of school performance consistently show virtual school outcomes that lag significantly behind those of traditional brick-and-mortar schools," Gulosino says. "While this finding did not surprise us, given past research with similar findings, we were surprised to find that blended schools tended to score similarly or lower on performance measures than virtual schools."

Study recommendations

The authors recommend that, given the rapid growth of virtual and blended schools and their relatively poor performance, policymakers should slow or stop the growth in the number of schools and the size of their enrollments until the reasons for their performance have been addressed.

Among other recommendations, the researchers suggest increased oversight and regulations to require the private operators to devote more of the public resources they receive to instructional costs.

For more information or a copy of the study, visit nepc.colorado.edu/publication/virtual-schools-annual-2016. ■

Dr. Deepak Ravindra displays one of Micro-LAM's diamond-cutting tools.

Degree research evolves into new company for **WMU alumni in semiconductor industry**

A silicon lens precisely machined by Micro-LAM reflects Ravindra and some of his team members.

Dr. Deepak Ravindra became a business owner at the same time he completed his doctoral degree through a unique collaboration with a faculty researcher focused on developing methods to machine extremely hard and brittle materials.

Ravindra worked with Dr. John Patten, former chair of WMU's manufacturing and engineering department, to launch Micro-Laser Assisted Machining Technologies—Micro-LAM—in July 2012.

The new technology they have developed utilizes a diamond-cutting tool capable of focusing gigawatts of laser power onto a concentrated surface to soften the material so a diamond can easily cut it.

"People cut with diamonds, people cut with lasers—we merged the two into a hybrid device," Patten says.

The technology could replace the current method for making advanced engineered ceramics and semiconductors smooth—a lengthy and expensive polishing process.

"In the machining industry, materials are getting better, but the manufacturing of them is getting trickier," says Ravindra, who earned his bachelor's, master's and doctoral degrees at WMU.

"When I entered the Ph.D. program, I was looking for a dissertation project in which I solved either a societal or industrial problem. Three to four companies that we were already working with had a grant for this kind of research, so we collaborated. John submitted an NSF (National Science Foundation) proposal and was awarded close to $1 million, so I decided to do my Ph.D. along those lines."

As part of the process to launch a business, in March 2012 Patten and Ravindra were selected to attend an Innovation Corps boot camp hosted by Stanford University and the National Science Foundation with their product, where they were required to interview a minimum of 100 potential customers.

Acceptance into I-Corps came with a $50,000 grant to help. The NSF provided another $850,000 to get the company off the ground, which has already received state-level recognition as a semifinalist in the Accelerate Michigan business plan competition.

Micro-LAM now leases a manufacturing facility owned by Battle Creek Unlimited, an economic development and business assistance resource in Battle Creek, Michigan.

Within two years of completing his doctorate, Ravindra had engaged with about 160 prospective companies to identify 25 as strategic partners—a group that has a cumulative value of about $100 billion.

"We have grown from a one-person company to a staff of nine, which includes WMU graduate and undergraduate students," he says. "I am very proud of WMU, and almost everyone working with me has a WMU connection. It is a great sense of accomplishment to see things happen and to make an impact in such a short period of time."

When he was a young man new to WMU's campus, Ravindra says his goals were very lofty and he aspired to "solve every problem on the face of the earth."

He soon figured out how little he knew about the engineering world he intended to enter, but says he found plenty of chances to learn what he needed to know to become a successful researcher and business owner.

"In WMU's engineering college, even as undergraduates, we were taught to engage very closely with industry," Ravindra says.

"Many students at other universities don't get to do that, which can cause a huge disconnect between the academic and real worlds. Students need that engagement to become marketable. They need to have meaningful senior research projects and to go through the entire process to see how things work in a commercial setting. It is important to me that my company inspires a spirit of entrepreneurship in our employees."

And well remembering his own academic roots, Ravindra also is "paying it forward" with current WMU students. More than a dozen have interned at Micro-LAM since its inception. ■

The CEO peers inside a laser-assisted machining setup at the company's headquarters.

Continued from page 21: HeroRATs

It took Weetjens and his research team six years to breed the rats in captivity, and domesticate and train them. By mid 2004, he says the first 11 HeroRATs were tested and accredited by the UN in Mozambique according to International Mine Action Standards.

"Although this was a great success," he says, "it took another five years before APOPO's detection rats technology really gained acceptance in the mine action communities."

With the dearth of scientific papers on the subject, people were skeptical about the efficacy of using animals for this kind of work.

Enter Poling and his particular research methodology pertaining to assessing and changing behavior. Prior to his involvement, APOPO wasn't publishing much and he helped increase its scientific output.

This is why Weetjens has high praise for the WMU psychology professor.

"If APOPO's HeroRATs were finally accepted as a reliable detection tool, credits go to Dr. Poling and his researchers.

"Looking back over the last seven years and the impact of Dr. Poling's adaptations to APOPO's experimental design, the refinement of the training procedures, the steep increase in overall reliability and effectiveness of detection-rat technology, let alone all the publications that resulted from this humanitarian quest, it is not exaggerated to claim that Dr. Al Poling and his team of researchers have significantly impacted humanitarian action in the world," Weetjens says.

Just last year, Mozambique was declared free of land mines, and HeroRATs played a crucial part in that, according to Weetjens.

"Through the HeroRATs, over 60,000 explosive devices have been found and neutralized in one of the poorest countries in the world, and more than a million displaced people have returned to their land, to resume a life free of fear," he says. ■

Continued from page 15: GRACE

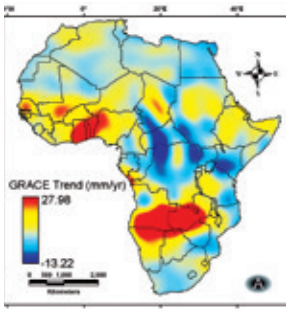
"We've never had these capacities before," Sultan says. "GRACE is opening up new avenues of research and applications."

Countries that share aquifers also can benefit from what GRACE reveals. If one country pumps more water, it deprives others of their share. The Nubian Aquifer, for example, provides groundwater for Egypt, Libya, Sudan and Chad.

"If you can measure it, you can reach more informed decisions about the optimum ways to use it, which in turn allows countries to make informed and equitable agreements as to how to split their shared water resources—and verify compliance," Sultan says.

Understanding the hydrologic setting of aquifers and watersheds and figuring out optimum ways to use these systems is of prime importance across the globe.

"Before, the only way we could accomplish this target was by constructing, calibrating and applying hydrologic models," Sultan says. "With GRACE, we now have powerful tools to measure mass variations, develop optimum utilization scenarios and estimate with precision the longevity of these systems under various management scenarios."



Although his lab's work has been mainly focused on Saharan Africa, he sees the possibility of similar research in southwestern Michigan to study how water from ancient glaciers, now residing in deposits of varying compositions, could be used effectively to support agriculture.

GRACE exposes where extraction of groundwater for farming is causing a decrease in groundwater mass with time and where it isn't. This knowledge could help provide guidance for land-use purposes.

Raising awareness

Sultan and his remote sensing teams make their findings available through technical papers as well as national and international conferences. They also knock on the doors of officials in various countries to raise awareness about the condition of their water resources.

"It would be naïve to think that what makes sense to us will be implemented," Sultan says. "However, we have a responsibility as scientists to validate and verify as much information as we can so that decisions at higher levels can be made intelligently. We hope that some of what we find will be taken into consideration."

Thus, Sultan finds his work to be both vital for the public good and personally enjoyable.

"This is an exciting field to be in today," he says. "I'm fortunate to have the chance to be on a science mission team for GRACE that has opened up opportunities to do research on critical scientific issues that affect the livelihood of many people around the world." ■

Researchers studying **impact of speed on crashes**

A team of three WMU researchers has been awarded a $161,802 grant from the Michigan Department of Transportation to study whether changing speed limits on Michigan interstate freeways has had an impact on crash types and severity.

The grant was awarded to Drs. Valerian Kwigizile and Jun-Seok Oh, assistant professor and professor, respectively, of civil and construction engineering, and Dr. Hyunkeun Cho, assistant professor of statistics. The team will study how changes in speed limits have impacted the frequency and severity of crashes.

In 1996, Michigan passed legislation to increase the speed limit along certain segments of interstate highways from 65 to 70 mph, Kwigizile says. A study by Michigan State University shortly after that found the marginal increase in speed did result in an increase in accidents.

"Since it has been a long time, the Michigan Department of Transportation wants to conduct another study to see whether those findings are still valid," Kwigizile says. "And since we have more segments where speed limits have changed, they want to expand the study that was done by MSU and get better results."

The research team began gathering data in March and hopes to complete the study by December 2017. One would expect that raising the speed limit would result in more accidents, Kwigizile says. But that isn't necessarily so.

"Different studies have shown different results," Kwigizile says. "There are some studies that have shown that increasing speed does not increase the number of crashes. However, there is one finding that is consistent throughout studies, which is increasing speed increases the severity of crashes."

The team will study different freeways. Sites will be spread throughout the state to capture different geographical characteristics. Researchers will look at crash data and speed profiles both before and after the speed limit was raised in 1996.

"We hope to see if there was an increase right after the speed limit was changed and then, after that, they went down," Kwigizile says.

The first objective will be to determine if the findings of the original MSU study in 1997 still hold true. The other objective is to see what the real impact is of changing speed limits.

The team also will do an economic analysis to assess the cost of increasing speed limits, including the cost of crashes and the cost of infrastructure changes, but also the benefits of shorter travel time. Other aspects of economic analysis will include emissions, noise impacts, pavement impacts and fuel consumption.

"The state is interested in knowing if what they are doing is cost beneficial," Kwigizile says. ■

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The Detroit Tigers struck gold when 4,100 people from the Bronco community showed up at Comerica Park June 22. Part of the ballpark crowd featured brown and gold as WMU alumni, friends, faculty, staff and students were in force for WMU Night at the Tigers' stadium. The Tigers beat the Seattle Mariners, 5 to 1. And President Dunn introduced Buster to PAWS.